Bead-Pull RF Measurement System

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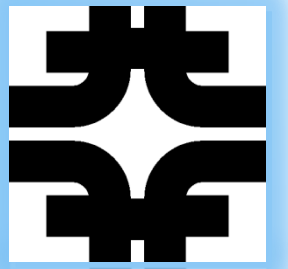


Outline

- Bead-Pull RF Measurement System
- Motivation
- Project Setup
- LabVIEW Program
- Test Measurements

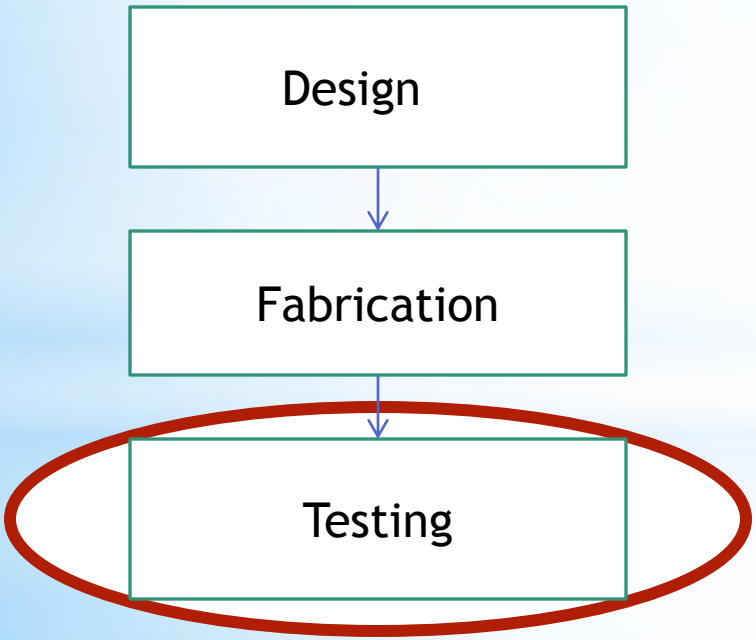
Bead-Pull RF Measurement System

- Bead (dielectric/metallic) being pulled through a cavity
- Take Resonant frequency measurements
- Goal: Know the electric field distribution inside the cavity.
- Slater Perturbation Theory

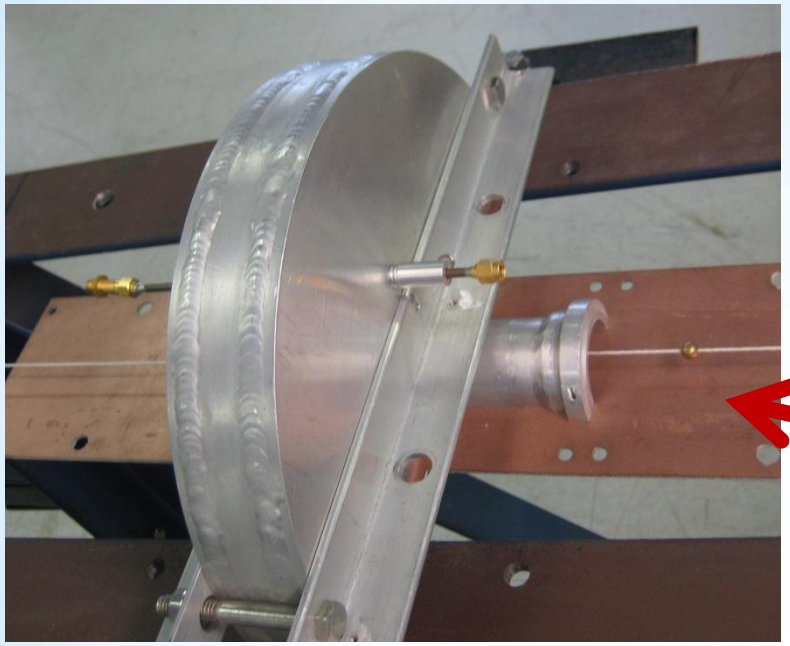
$$\frac{\omega^2 - {\omega_0}^2}{{\omega_0}^2} = k \int_{\Delta r} \frac{\mu H^2 - \epsilon E^2}{2U} \, dv$$

Motivation

- Most accelerators use RF cavities
- After fabrication, use Bead-Pull System to ensure that the electric field distribution is as designed



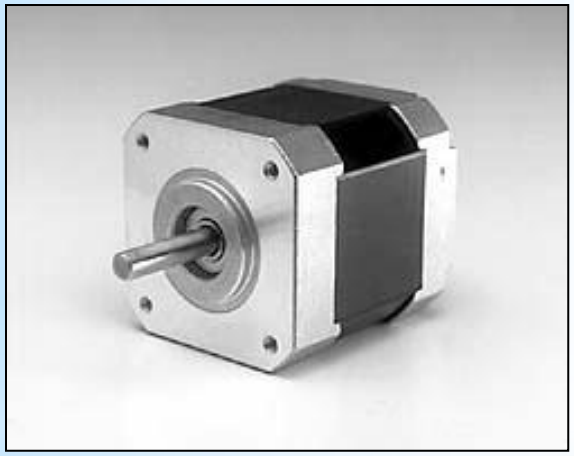
Bead-Pull RF Measurement System



- Cavity
- Bead, Thread & Pulley System
- Motor
- Network Analyzer
- Computer (control software)

Equipment

Step Motor



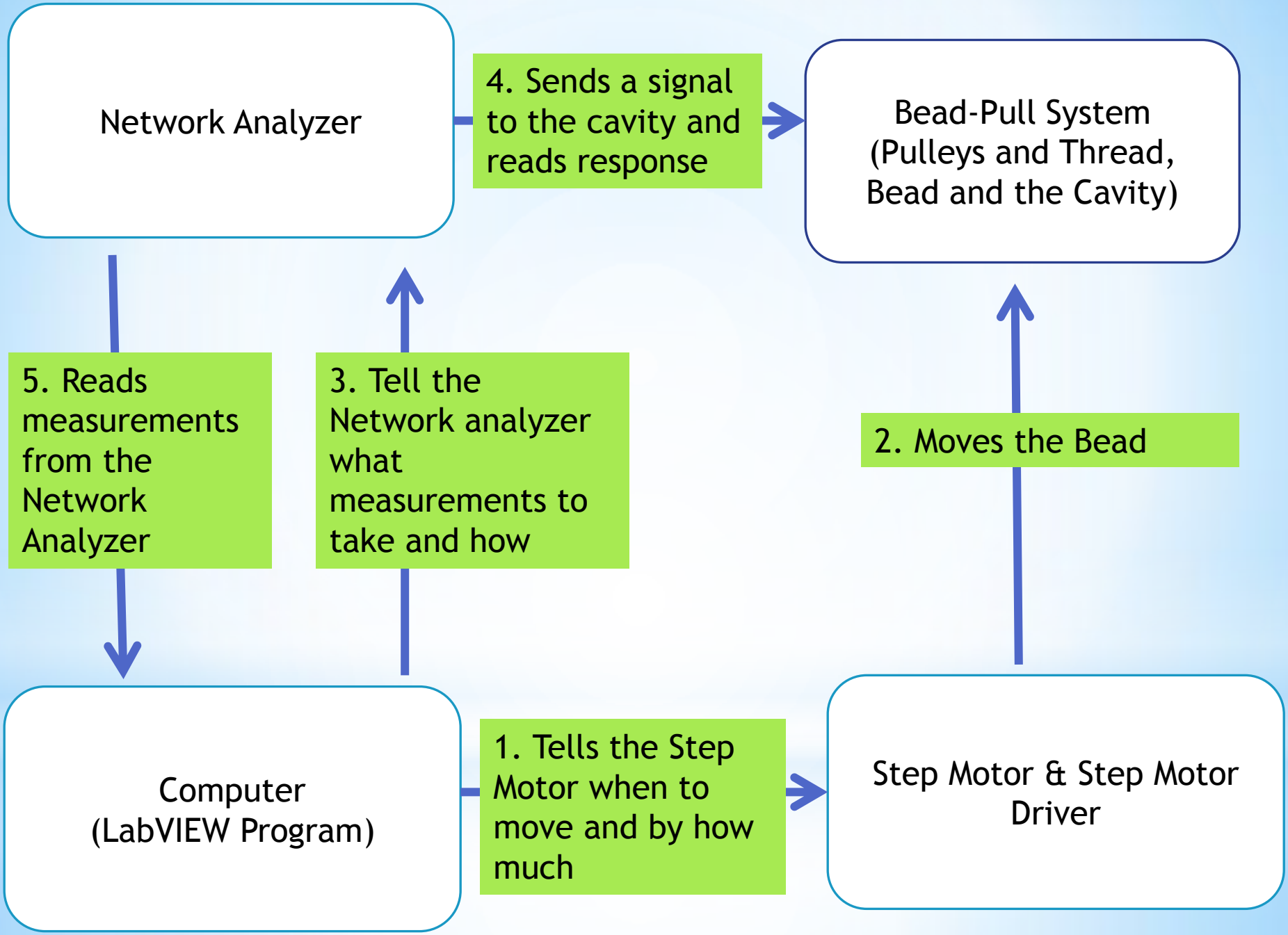
- HT23-601 by Applied Motions
- 20,000 steps/rotation
- Approx. 255 steps moves the bead by 1mm

Network Analyzer

- Agilent 8720ES
- Takes the Radio Frequency measurements

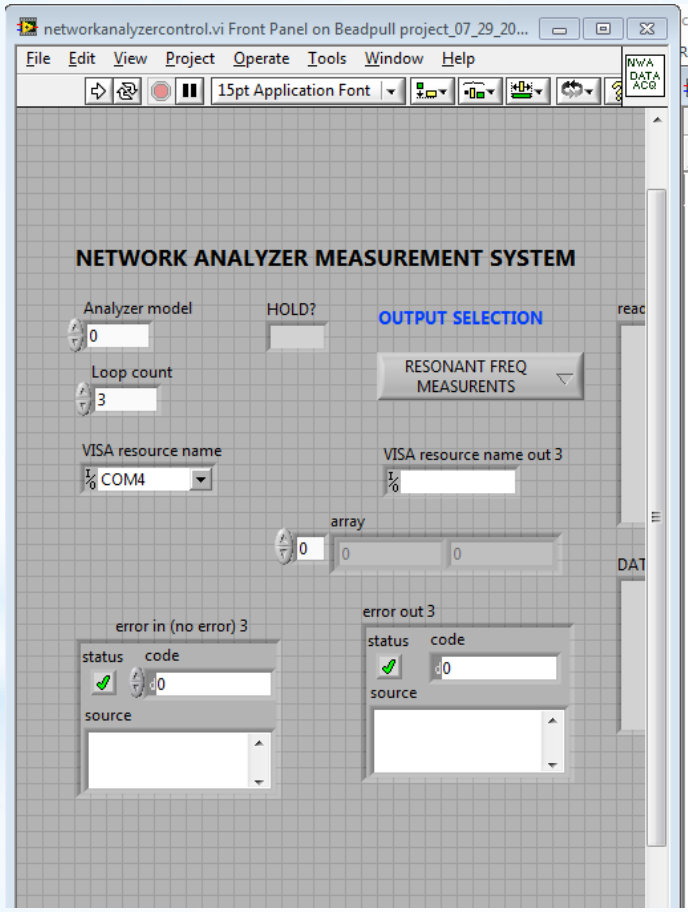
Objectives

- LabVIEW program that controls both the Step Motor and Network Analyzer
- Check the accuracy of the measurements from the Network Analyzer and the motion of the Step Motor

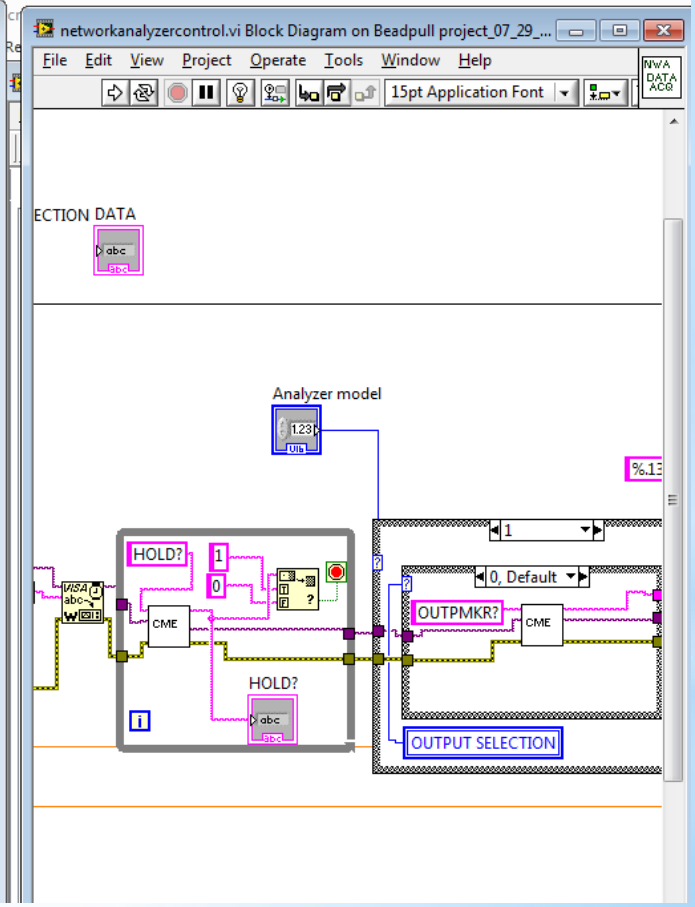

Network Analyzer
4. Sends a signal to the cavity and reads response
Bead-Pull System (Pulleys and Thread, Bead and the Cavity)
5. Reads measurements from the Network Analyzer
3. Tell the Network analyzer what measurements to take and how
2. Moves the Bead
Computer (LabVIEW Program)
1. Tells the Step Motor when to move and by how much
Step Motor & Step Motor Driver

- National Instruments' Software
- Graphical Programming Environment

A LabVIEW program is called a virtual instrument (VI)



Front Panel



Block Diagram

Approach

Network Analyzer VI

Control how measurements are taken

Step Motor VI

Control the motion of the bead

Overall Bead Pull System VI

Operates both the Step Motor VI and Network Analyzer VI as required

Bead Pull System.vi

File Edit View Project Operate Tools Window Help

BEAD-PULL RF MEASUREMENT SYSTEM

STEP MOTOR PARAMETERS

Velocity	Acceleration Rate	Deceleration Rate
10	25	25

INPUT SPECIFICATIONS

ANALYZER MODEL SELECTION

AGILENT 8720ES

OUTPUT SELECTION

RESONANT FREQ MEASUREMENTS

File Datapath

Z:\Jackline Koech\LabVIEW\HP4396\TEST.csv

Steps/mm)	Step size(mm)	Start distance	Stop distance(mm)
254.71	0.1	0	200

Comments

Agilent 8720ES, resonant freq measurements

NWA VISA resource in: COM4

NWA VISA resource out: COM4

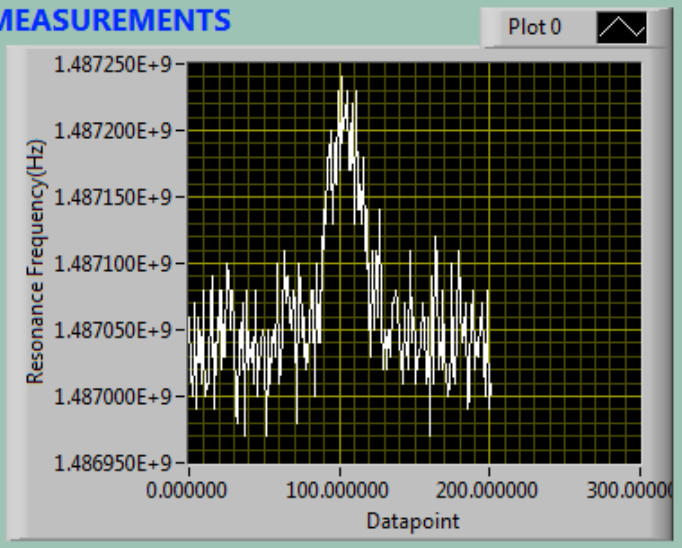
Motor VISA resource: COM1

Motor Visa resource out: COM1

error in: status, code 0

error out: status, code 1073676294

RESONANCE FREQUENCY MEASUREMENTS



OUTPUT PANEL

STEPS/stepsize	Distance moved	Total steps moved
25	59.2	14800

Running

Data

```
0,-4.884609E+01,  4.538155E+04,  1.487030000E+09,
1,-4.881508E+01,  4.582165E-24,  1.486970000E+09,
2,-4.878693E+01,  1.161769E+07,  1.487060000E+09,
3,-4.883217E+01,  6.386886E+18,  1.487040000E+09,
4,-4.883993E+01,  8.535699E-33,  1.487080000E+09,
5,-4.876726E+01,  6.006204E-19,  1.487050000E+09,
6,-4.883616E+01,  4.127246E-08,  1.486990000E+09,
7,-4.884594E+01,  3.630524E+05,  1.487040000E+09,
8,-4.886055E+01,  7.872094E-14,  1.486990000E+09,
9,-4.882817E+01,  8.535700E-33,  1.487130000E+09,
10,-4.882404E+01,  1.056668E-05,  1.487100000E+09,
11,-4.881540E+01,  3.579975E-26,  1.487030000E+09,
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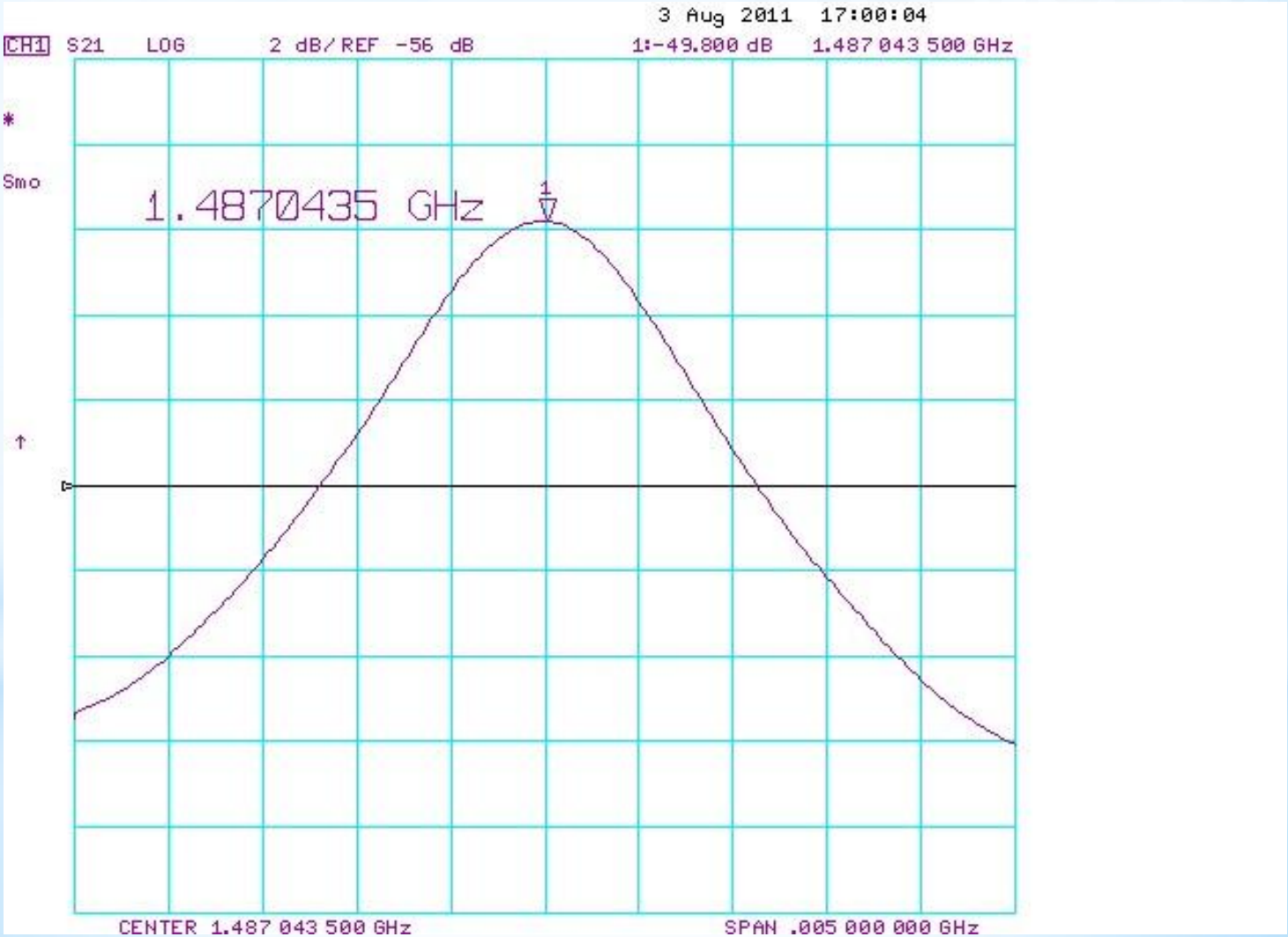
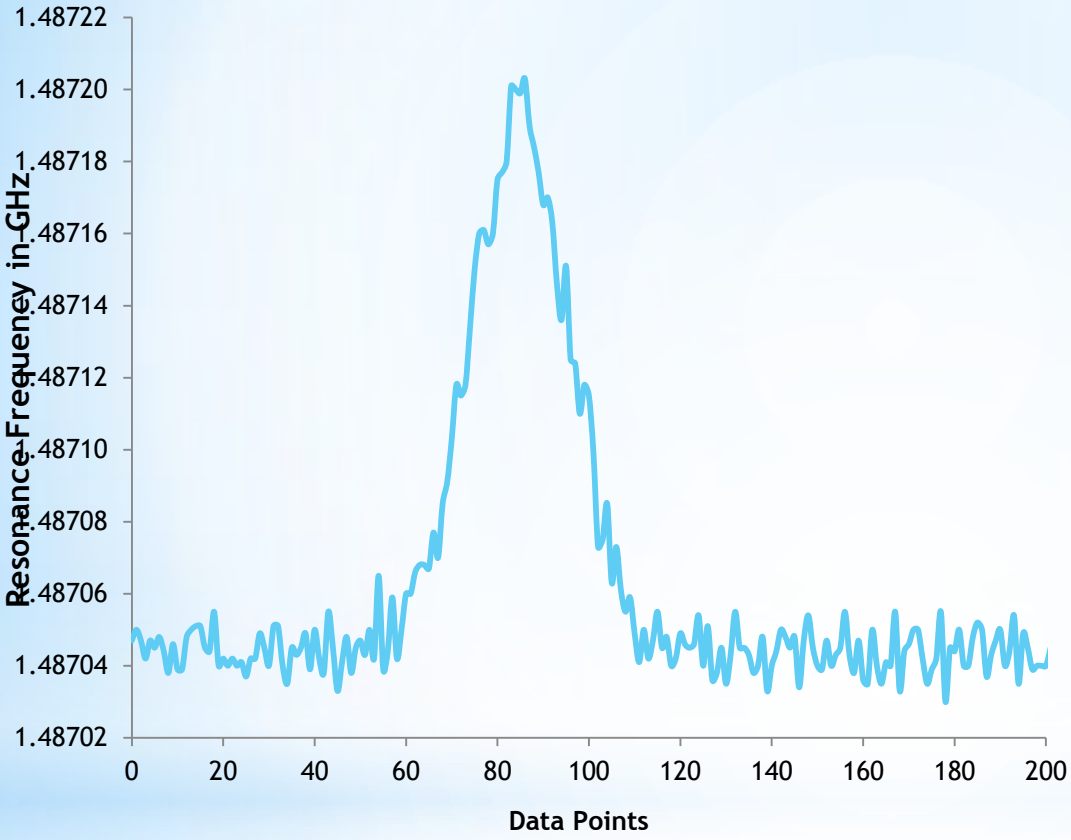
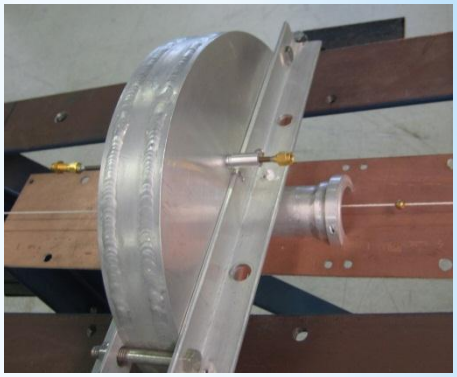
Beadpull project.lvproj/My Computer

Measuring the Resonant Frequency



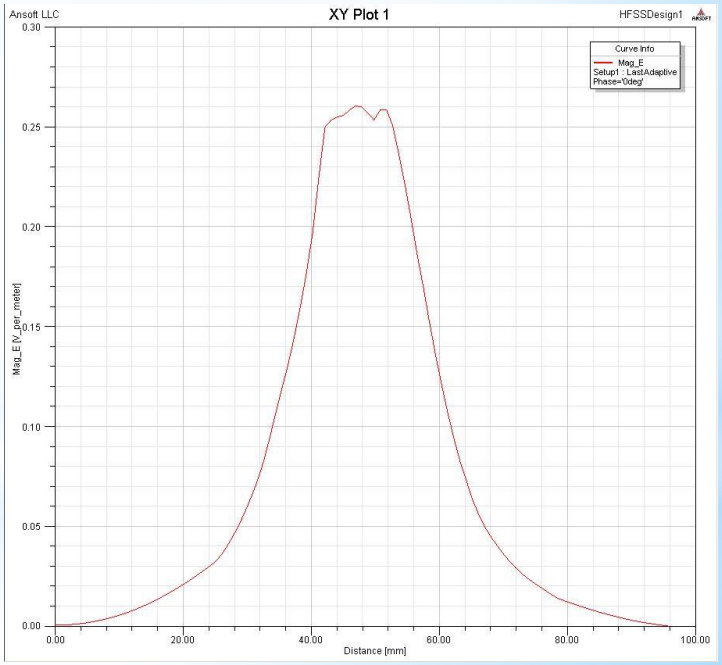
Pill Box Test Cavity Measurements





The bead-pull system moves the bead accurately as required

The system acquires the data correctly from the Network Analyzer



Simulated electric field

Conclusion

We have successfully developed a software that controls the Bead-Pull System hardware

-Moves the bead accurately

-Takes Measurements accurately

Acknowledgements

- Fermilab SIST committee
- Supervisor: David Peterson
- Ding Sun and His group
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- DrJames Davenport.
- Antiproton Source Department

Questions??